Inter (Part-I) 2018

Physics	Group-I	PAPER: I
Time: 2.40 Hours	(SUBJECTIVE TYPE)	Marks: 68

SECTION-I

2. Write short answers to any EIGHT (8) questions: (16)

(i) Define and explain scientific notation, also give example.

Ans Numbers which are expressed in standard form called scientific notation, which employs the power of ten (10). In standard form, there must be one non-zero digit before a decimal.

Example:

$$7.2 \times 10^2.$$

(ii) Show that the expression $v_f = v_i + at$ is dimensionally correct.

Ans Data:

Equation of motion is:

$$v_f = v_i + at$$

where v_f = final velocity , v_i = initial velocity.

a = acceleration

To show:

The expression $v_f = v_i + at$ is dimensionally correct.

Proof:

As $v_f = v_i + at$

Dimension of L.H.S of the equation = $[v_f] = [LT^{-1}]$.

Dimension of R.H.S of the equation

$$= [v_i] + [a][t]$$

$$= [LT^{-1}] + [LT^{-2}][T]$$

$$= [LT^{-1}] + [LT^{-1}]$$

(iii) Write any two uses of dimensional analysis.

Ans Following are the two uses of dimensional analysis:

1. We can check the correctness of a given formula or an equation and can also derive it.
2. Dimensional analysis makes use of the fact that expression of the dimensions can be manipulated as algebraic quantities.

(iv) Name several repetitive phenomenon occurring in nature which could serve as reasonable time standards.

Ans Any natural phenomenon that repeats itself after same or regular time interval can serve as a time standard. Following are some natural phenomenon that can serve as time standard:

- Rotation of Earth around Sun.
- Movement of Moon around Earth.
- Movement of Earth about its own axis.
- Sun can serve as time standard.

(v) Can the magnitude of a vector have a negative value?

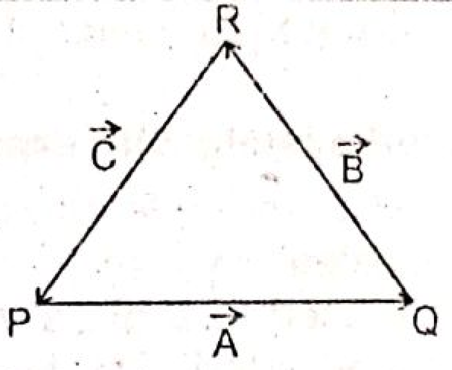
Ans We know that:

$$A = \sqrt{A_x^2 + A_y^2}$$

If either of the component is taken as negative, then the square of negative quantities will give positive value. Hence, the magnitude of a vector cannot have negative value.

(vi) The vector sum of three vectors gives a zero resultant. What can be the orientation of the vectors?

Ans The vector sum of three vectors gives a zero resultant, if the three vectors act along the adjacent sides of triangle taken in order as show in figure. From figure, we have $\vec{A} + \vec{B} + \vec{C} = 0$.



(vii) Define the terms:

(i) Null vector **(ii) Subtraction of vector**

Ans **(i) Null vector:**

Null vector is a vector of zero magnitude and orbitrary direction. For example, the sum of a vector and its negative vector is a null vector.

$$A + (-A) = 0$$

(ii) Subtraction of vector:

The subtraction of a vector is equivalent to the addition of the same vector with its direction reversed. Thus, to subtract vector B from vector A, reverse the direction of B and add it to A.

$A - B = A + (-B)$, where $(-B)$ is negative vector of B.

(viii) What happens when a very heavy body collides with lighter stationary body? Explain.

Ans When a very heavy body collides with lighter stationary body, then there is practically no change in the velocity of massive body, but the lighter one bounces off in the forward direction with approximately twice the velocity of the incident body.

(ix) Can the velocity of an object reverse direction when acceleration is constant? If so, give an example.

Ans Yes, the velocity of an object can reverse the direction when acceleration is constant.

Example:

When an object is thrown vertically upward, the velocity reverses its direction at maximum height, when the body starts falling downward. But the acceleration of

the body remains constant throughout its motion equal to $9.8\ ms^{-2}$.

(x) Define isolated system with example.

Ans A system on which no external agency exerts any force is called isolated system. For example, the molecules of gas enclosed in a glass vessel at constant temperature constitute an isolated system.

(xi) Two boats moving parallel in the same direction are pulled towards each other. Explain why?

Ans When two boats are moving parallel in the same direction, the velocity of water in between them increases due to their motion and hence, pressure decreases. Thus, the water on the outer side being at high pressure exerts the force on the boats towards low pressure side. As a result, the boats are pulled toward each other.

(xii) Explain the difference between laminar flow and turbulent flow.

Ans The flow is said to be streamline or laminar, if every particle that passes a particular point, moves along exactly the same path, as followed by particles which passed that points earlier. While the irregular or unsteady flow of the fluid is called turbulent flow.

3. Write short answers to any EIGHT (8) questions: (16)

(i) When a rocket re-enters the atmosphere, its nose cone becomes very hot, where does this heat energy comes from?

Ans There is a large number of dust particles and water vapours present in the air. When a rocket re-enters the atmosphere, it has to face the resistance due to particles. Some K.E. of the rocket is converted into heat energy. Therefore, the cone nose of the rocket becomes very hot due to the heat energy produced by the fluid friction of atmosphere.

(ii) What sort of energy is in compressed spring and water in a high dam?

Ans A compressed spring has elastic potential energy, and water in high dam has gravitational potential energy.

(iii) Write two merits and demerits of solar cells.

Ans Two merits and demerits of solar cells are given below:

Merits:

1. Solar cells are used to power satellites having large solar panels which are kept facing the Sun.
2. Solar cells are also used in remote ground based weather stations and rain forest communication system.

Demerits:

1. Solar cells cannot be used in absence of light from any source.
2. During cloudy weather, less power is being generated.

(iv) Explain how many minimum number of geo-stationary satellites are required for global coverage of T.V. transmission.

Ans Three geostationary satellites are required for global coverage of TV transmission. Each covers 120°. As $120° \times 3 = 360°$.

(v) Show that orbital angular momentum $L_o = mvr$.

Ans Angular momentum is given as:

$$\vec{L} = \vec{r} \times \vec{p}$$

Magnitude of angular momentum is:

$$L_o = r\,p \sin\theta \qquad \text{(i)}$$

Where θ is angle between r and p.

Linear momentum is given as:

$$\vec{p} = m\vec{v}$$

Magnitude of linear momentum is:

$$p = mv$$

Putting this value in (i),

$$L_o = r\,m\,v \sin\theta$$

Let the object is moving in such a way that

$$\theta = 90$$

$$L_o = m\,v\,r \sin 90^\circ$$

$$L_o = m\,v\,r\,(1)$$

$$L_o = m\,v\,r \quad \text{Hence Proved.}$$

(vi) Find total kinetic energy of rolling sphere of mass 'm' and radius 'r' on horizontal smooth surface.

Ans The moment of inertia of sphere is $I = \frac{2}{5}mr^2$.

$$K.E_{rot} = \frac{1}{2}I\omega^2 \qquad \because \omega = \frac{V}{r}$$

$$= \frac{1}{2}\left(\frac{2}{5}mr^2\right)\left(\frac{V}{r}\right)^2$$

$$\boxed{K.E_{rot} = \frac{1}{5}mV^2}$$

(vii) Prove that $\omega = \sqrt{\frac{k}{m}}$ for mass spring system.

Ans As we know that

$$a = \frac{-k}{m}x \qquad \text{(i)}$$

where k is a spring constant,

Since, $\frac{k}{m}$ = constant

Here $a \propto -x$

Thus, the mass m executes the SHM between A and A with amplitude x_o.

We know that the acceleration of a body executing SHM is:

$$a = -\omega^2 x \qquad \text{(ii)}$$

From eqs. (i) & (ii), we have,

$$\omega^2 = \frac{k}{m}$$

$$\omega = \sqrt{\frac{k}{m}}$$

Hence proved.

(viii) How displacement and amplitude are related for mass spring system?

Ans The displacement of simple harmonic oscillator is given as:

$$x = x_m \cos(\omega f + \phi)$$

The maximum displacement of simple harmonic oscillator from mean position is called amplitude.

$$\text{Amplitude} = x_m \cos(\omega t + \phi)_{max} = x_m (\pm 1)$$

$$\text{Amplitude} = x_m$$

(ix) What happens to the period of a simple pendulum if its length is doubled? What happens if the suspended mass is doubled?

Ans As we know:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

According to given condition, if length is doubled *i.e.*, $l' = 2l$

$$T' = 2\pi\sqrt{\frac{l'}{g}}$$

$$T' = 2\pi\sqrt{\frac{2l}{g}}$$

$$= \sqrt{2}\left(2\pi\sqrt{\frac{l}{g}}\right)$$

$$= \sqrt{2}\,T$$

$$= 1.41T$$

It means, time period increases by $\sqrt{2}$ times.

→ The time period of simple pendulum is independent of mass. Therefore, if mass is doubled, there will be no change in 'T'.

(x) Explain the term crest, trough, node and antinode.

Ans **Crest:**

The portion of disturbance of a transverse wave, which is above the mean position, is called crest.

Trough:

The portion of disturbance of a transverse wave, which is below the mean position, is called trough.

Node:

The points of zero displacement in stationary waves is called node.

Antinode:

Those points which have maximum displacement on either side of mean position are called antinodes.

(xi) As a result of a distant explosion, an observer senses a ground tremor and then hears the explosion. Explain the time difference.

Ans The sound waves produced by the explosion reach the observer via two different media. Those sound waves which travel through ground reach earlier than air, because sound travels faster in ground than air. Its reason is that earth has higher density. Thus, a ground tremor is felt before hearing the sound explosion. This is the reason of time difference between ground tremor and sound of the explosion.

(xii) Why does transverse wave reflecting from a denser medium undergo a phase change of 180°?

Ans When a wave undergoes a reflection at a denser medium, then its crest reflected as trough and vice versa. So, its phase changes at 180°.

4. Write short answers to any SIX (6) questions: (12)

(i) Differentiate between polarized and unpolarized light.

Ans When light is passed through a polaroid, the emerging light beam has all the electric vectors confined in one plane at right angles to its direction of propagation. Such light is called plane polarized light (polaroid is named

as polarizer). When another polaroid is placed in the path of polarized light with its axis parallel to the first polaroid, the total light will pass through the second polaroid. If second polaroid is rotated through 90°, no light passes through it, but ordinary or unpolarized light will totally pass through it in all directions. This second polaroid distinguishes the plane-polarized light from ordinary or unpolarized light. The polaroid used to test polarized light is called an analyzer.

(ii) What aspect of nature of light is proved by the phenomena of polarization?

Ans Polarization proves that light is a transverse wave, travelling in a direction perpendicular to both its electric and magnetic components as light is a form of electromagnetic radiation.

(iii) Explain briefly whether the Young's experiment is an experiment for studying interference or diffraction effects of light

Ans Young's double slit experiment is an experiment for studying interference effects of light. Since, light bends around the edges of the slits to produce the interference pattern on the screen. Therefore, this experiment can be used to study the diffraction effect of light.

(iv) Differentiate between linear magnification and angular magnification.

Ans **Linear magnification:**

It is the ratio of size of the image to the size of an object.

$$M = \frac{I}{O} = \frac{q}{p}$$

Angular magnification:

It is ratio of visual angle subtended by the image as seen through the optical instrument to that subtended by the object at the unaided eye.

(v) Why would it be advantageous to use blue light with a compound microscope?

Ans For a better resolution, objective of large aperture and use of blue light of short focal length is recommended because blue light is less diffracted as, $\alpha_{min} = 1.22 \frac{\lambda}{D}$.

Here, λ should be small to get less value of α_{min}.

(vi) Derive Charles's law from kinetic theory of gases.

Ans As we know,

$$V = \frac{2N}{3P}\left(\frac{1}{2}mv^2\right)$$

When pressure is constant.

$$V \propto \langle \frac{1}{2}mv^2 \rangle$$

$$\because \quad T \propto \langle \frac{1}{2}mv^2 \rangle$$

$$V \propto T$$

"The volume is directly proportional to absolute temperature of gas provided pressure is kept constant. It is known a Charles' Law."

(vii) Define internal energy of a substance.

Ans The sum of all forms of microscopic kinetic and potential energies of the molecules of a substance is termed as internal energy of a substance.

(viii) Give an example of a natural process that involves an increase in entropy.

Ans When ice is melted due to high temperature of surroundings, the heat is transferred to ice from surroundings is positive. Since, $\Delta S = \frac{\Delta Q}{T}$. As ΔS is positive, thus entropy of natural process increases.

(ix) Is it possible to construct a heat engine that will not expel heat into the atmosphere?

Ans No, it is not possible to construct a heat engine that will not expel heat into atmosphere. Since, environment

act as cold body or sink of heat engine to which apart of heat energy is to be rejected.

SECTION-II

NOTE: Attempt any Three (3) questions.

Q.5.(a) Define elastic and inelastic collision. Discuss elastic collision in one dimension and show that velocity of approach is equal to the velocity of separation. (5)

Ans **Elastic collision:**

"A collision in which both K.E and momentum are conserved is called elastic collision."

Inelastic Collision:

"A collision in which momentum is conserved but kinetic energy of the system is not conserved is called as inelastic collision."

Elastic Collision in one Dimension:

Consider two smooth non-rotating balls of masses m_1 and m_2 moving with velocity v_1 and v_2 along same direction. During motion, they collide and after collision, they keep on moving along straight line with velocities v_1' and v_2'. Since, collision is elastic, the momentum and K.E will be conserved.

Applying law of conservation of momentum.

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

$$m_1v_1 - m_1v_1' = m_2v_2' - m_2v_2$$

$$m_1 (v_1 - v_1') = m_2 (v_2' - v_2) \qquad (1)$$

Applying law of conservation of energy

$$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}m_1v_1'^2 + \frac{1}{2}m_2v_2'^2$$

$$m_1v_1^2 + m_2v_2^2 = m_1v_1'^2 + m_2v_2'^2$$

$$m_1(v_1^2 - v_1'^2) = m_2(v_2'^2 - v_2^2) \qquad (2)$$

Dividing eq (2) by eq (1)

$$\frac{m_1(v_1^2 - v_1'^2)}{m_1(v_1 - v_1')} = \frac{m_2(v_2'^2 - v_2^2)}{m_2(v_2^1 - v_2)}$$

$$\frac{m_1(v_1 + v_1')(v_1 - v_1')}{m_1(v_1 - v_1')} = \frac{m_2(v_2' + v_2)(v_2' - v_2)}{m_2(v_2^1 - v_2)}$$

$$v_1 + v_1' = v_2' + v_2$$

$$v_1 - v_2 = v_2' - v_1'$$

$$v_1 - v_2 = -(v_1' - v_2')$$

Speed of approach = speed of separation

Conclusion:

Here $(v_1 - v_2)$ is velocity of 1st ball relative to the 2nd ball before collision. Similarly, $(v_1' - v_2')$ is velocity of 1st ball relative to 2nd ball after collision.

(b) A load of 10 N is suspended from a clothes line. This distorts the line so that it makes an angle of 15° with each end. Find tension in the clothes line. (3)

Ans **Given Data:**

Load = W = 10 N

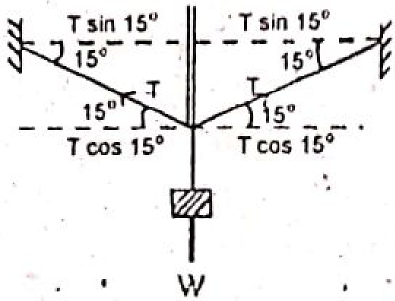
Angle at each end = θ = 15°

To Determine:

Tension in clothes line = T = ?

Calculation:

We resolve the tension T into rectangular components as shown in fig.



For equilibrium, we have

Sum of upward forces = Sum of downward forces

i.e., $T \sin 15^\circ + T \sin 15^\circ = W$

$$2T \sin 15^\circ = W$$

or $$T = \frac{W}{2 \times \sin 15^\circ}$$

$$T = 19.3 \text{ N}$$

Q.6.(a) What is escape velocity? Derive an expression for it and calculate its value on the surface of the earth. (5)

Ans It is our daily life experience that an object projected upward comes back to the ground after rising to a certain height..This is due to the force of gravity acting downward. With increased initial velocity, the object rises to the greater height before coming back. If we go on increasing the initial velocity of the object, a stage comes when it will not return to the ground. It will escape out of the influence of gravity. The initial velocity of an object with which it goes out of the Earth's gravitational field, is known as escape velocity.

The escape velocity corresponds to the initial kinetic energy gained by the body, which carries it to an infinite distance from the surface of Earth.

$$\text{Initial K.E.} = \frac{1}{2} m v_{esc}^2$$

We know that the work done in lifting a body from Earth's surface to an infinite distance is equal to the increase in its potential energy.

$$\text{Increase in P.E.} = 0 - \left(-G\frac{Mm}{R}\right) = G\frac{Mm}{R}$$

where M and R are the mass and radius of the Earth, respectively. The body will escape out of the gravitational field if the initial K.E. of the body is equal to the increase in P.E. of the body in lifting it up to infinity. Then,

$$\frac{1}{2} m v_{esc}^2 = G \frac{Mm}{R}$$

or $$v_{esc} = \sqrt{\frac{2GM}{R}} \quad \text{(i)}$$

As $$g = \frac{GM}{R^2}$$

Hence, $$v_{esc} = \sqrt{2gR} \quad \text{(ii)}$$

The value of v_{esc} comes out to be approximately 11 kms^{-1}.

(b) A 1000 kg car travelling with a speed of 144 kmh^{-1} round a curve of radius 100 m. Find the necessary centripetal force. (3)

Ans Given Data:

Mass of car = m = 1000 kg

Speed of car = v = 144 km / h

$$= \frac{144 \times 1000}{60 \times 60}$$

$$= 40 \text{ ms}^{-1}$$

Radius = r = 100 m

To Determine:

Centripetal force = F_c = ?

Calculation:

Using the formula

$$F_c = \frac{mv^2}{r}$$

Putting values, we get

$$= \frac{100 \times (40)^2}{100}$$

$$= \frac{1000 \times 1600}{100}$$

$$= 16000 = 1.6 \times 10^4 \text{ N}$$

$$\boxed{F_C = 1.6 \times 10^4\ N}$$

Q.7.(a) What is petrol engine? Describe its working by elaborating its four strokes and what is main difference between petrol engines and diesel engines. (5)

Ans Petrol Engine:

Although different engines may differ in their construction technology but they are based on the principle of a Carnot cycle. A typical four stroke petrol engine also undergoes four successive processes in each cycle:

1. The cycle starts on the intake stroke in which piston moves outward and petrol air mixture is drawn through an inlet valve into the cylinder from the carburetor at atmospheric pressure.
2. On the compression stroke, the inlet valve is closed and the mixture is compressed adiabatically by inward movement of the piston.
3. On the power stroke, a spark fires the mixture causing a rapid increase in pressure and temperature. The burning mixture expands adiabatically and forces the piston to move outward. This is the stroke which delivers power to crank shaft to drive the flywheels.
4. On the exhaust stroke, the outlet valves opens. The residual gases are expelled and piston moves inward.

Difference between petrol and diesel engines:

1. The petrol engine works on otto cycle, whereas, diesel engine works on diesel cycle.
2. In petrol engine, the air and petrol are mixed in carburetor and it enters into cylinder. In diesel engine, the fuel is first fed into the cylinder by a fuel injector and gets mixed with air inside the cylinder

(b) **336 J of energy is required to melt 1 gm of ice at 0°C. What is the change in entropy of 30 gm of water at 0°C as it is changed to ice at 0°C by a refrigerator? (3)**

Ans For Answer see Paper 2017 (Group-II), Q.7.(b).

Q.8.(a) What is Doppler Effect? Discuss the case when:

(i) Observer is moving towards a stationary source,

(ii) Observer is moving away from stationary source.

Ans **Doppler Effect:**

"The apparent change in the pitch of sound caused by the relative motion between source of sound and the listener is called Doppler's effect."

Example:

Suppose a person is standing on a railway platform. The apparent pitch of the whistle of the train increases when the train is approaching, the person but when the train moves away from the person, the apparent pitch of the whistle of the train decreases.

Case 1.

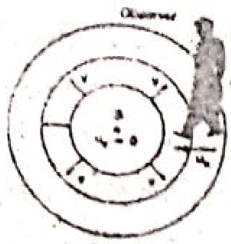
The observer is moving towards the sound source:

Suppose a source of sound emits a sound of frequency 'f' and wavelength 'λ'. Let the velocity of sound in the stationary medium is 'v'. If both the source and observer are stationary, then the number of waves received by the observer in one second is

$$v = f\lambda$$

$$\Rightarrow \quad \lambda = \frac{v}{f}$$

$$\text{and} \quad f = \frac{v}{\lambda}$$



If the observer 'A' is moving towards a stationary source with velocity u_0 as shown in the fig., the relative velocity of waves and observer is increased to

$$v - (-u_0) = v + u_0$$

Hence, number of waves received in one second or modified frequency 'f_A' is given by:

$$f_A = \frac{v + u_0}{\lambda}$$

$$f_A = \frac{v + u_0}{\frac{v}{f}} \quad \therefore \quad \lambda = \frac{v}{f}$$

$$f_A = \left(\frac{v + u_0}{v}\right) f$$

because $\frac{v + u_0}{v} > 1$

$\Rightarrow \quad f_A > f$

which shows that frequency will be increased.

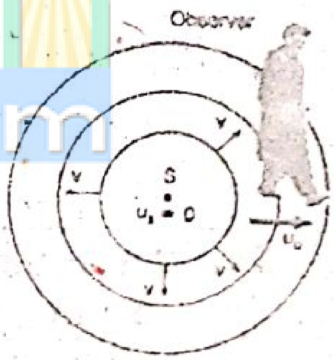
Case 2:

The observer is moving away from the sound source.

Let us consider the listener is moving away from the source with velocity v, the relative speed of sound with respect to listener is $v - u_0$.

$\therefore \quad v - u_0 = \lambda f_B$

where f_B is apparent frequency or modified frequency.



$$f_B = \frac{v - u_0}{\lambda}$$

Where, $\lambda = \frac{v}{f}$

Modified frequency will be

$$\therefore \quad f_B = \left(\frac{v - u_0}{\frac{v}{f}}\right)$$

$$f_e = \left(\frac{v - u_0}{v}\right) f$$

Because $\frac{v - u_0}{v} < 1$

$\Rightarrow \quad f_B < f$

Hence, the pitch of the sound will decrease as observer moves away from the source.

(b) A simple pendulum is 50.0 cm long. What will be its frequency of vibration at a place where g = 9.8 ms^{-2}? (3)

Ans Length of simple pendulum $= l = 50\text{ cm} = 0.5\text{ m}$

Acceleration $= g = 9.8\text{ ms}^{-2}$

Time period $= T = ?$

Frequency $= f = ?$

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$= 2 \times 3.14\sqrt{\frac{0.5}{9.8}}$$

$$T = 1.41\text{ s}$$

$$f = \frac{1}{T}$$

$$f = \frac{1}{1.41}$$

$$\boxed{f = 0.71\text{ Hz}}$$

Q.9.(a) Explain a simple microscope. Derive formula for its magnification. (5)

Ans **Definition:**

"An ordinary convex lens which is held close to the eye to magnify the image is called a simple microscope or magnifying glass."

When this lens is placed between eye and object, it helps us to see the details of an object by bringing it closer than 25 cm. A watch-maker uses convex lens to mend watches.

Principle:

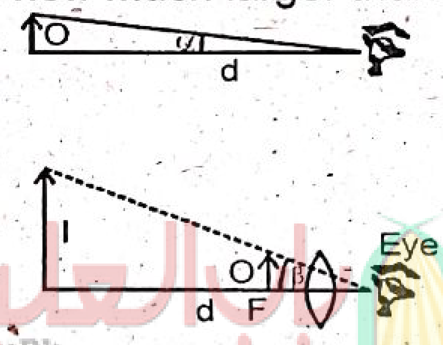
If a small object is placed within the principal focus of a convex lens, a virtual, erect and magnified image of the object is formed on the same side at least distance of distinct vision 'd'.

Formation of Image:

Consider an object O which is placed at a distance 'd' equal to least distance of distinct vision from the eye and it subtends an angle 'α' at the eye.

If the same object 'O' is placed within the focal length 'f' of a convex lens in front of eye at a distance 'p', then the lens forms its magnified, virtual and erect image I at a distance equal to d where it is seen comfortably by an eye. The angle subtended by the image I is 'β' at the eye. The size of the image is now much larger than without the lens.

(a) (b)



Magnifying Power:

The magnifying power of simple microscope is defined as:

"The ratio of the angle 'β' subtended at the eye by the image to the angle 'α' subtended by the object at the unaided eye; when both image and object are placed at distance 'd' of distinct vision."

$$\therefore \quad \text{Magnifying Power} = M = \frac{\beta}{\alpha} \qquad (1)$$

when angles are small, they are nearly equal to their tangents. By trigonometry,

$$\alpha = \tan\alpha = \frac{\text{Size of the object}}{\text{Distance of object}} = \frac{O}{d} \qquad (2)$$

$$\because \quad (\tan\alpha = \text{Perp. / Base})$$

$$\beta = \tan\beta = \frac{\text{Size of image}}{\text{Distance of image}} = \frac{I}{q} \quad (3)$$

Since, the image is at the least distance of distinct vision, so

$$q = d$$

Putting the value of q in equation (3), we have

$$\beta = \frac{I}{d} \quad (4)$$

Now, putting the values of 'α' from equation (2) and 'β' from equation (4), we get

$$M = \frac{I/d}{O/d}$$

Or $$M = \frac{I}{O} \quad (5)$$

As we already know that

$$M = \frac{\text{Size of image}}{\text{Size of object}} = \frac{\text{Distance of the image}}{\text{Distance of the object}}$$

Or $$M = \frac{I}{O} = \frac{q}{p} \quad (\because q = d)$$

Therefore, $$M = \frac{q}{p} = \frac{d}{p} \quad (6)$$

For virtual image, the lens formula is given by

$$\frac{1}{f} = \frac{1}{p} - \frac{1}{q}$$

But $q = d$

Therefore,

$$\frac{1}{f} = \frac{1}{p} - \frac{1}{d} \quad (7)$$

Multiplying both sides of equation (7) by d, we get

$$\frac{d}{f} = \frac{d}{p} - 1$$

or $$\frac{d}{p} = 1 + \frac{d}{f}$$

Putting the value of d/p in equation (6), we have

$$M = 1 + \frac{d}{f}$$

Hence, the magnifying power of simple microscope is expressed as

$$M = 1 + \frac{d}{f} \quad (8)$$

The equation shows that magnifying power of a simple microscope can be increased by using a convex lens of smaller focal length. For high angular magnification, we should use a lens of short focal length.

(b) Sodium light of wavelength λ = 589 nm, is incident normally on a grating having 3000 lines per centimeter. What is highest order of the spectrum obtained with this grating? (3)

Ans

$\lambda = 589$ nm, $\lambda = 589 \times 10^{-9}$ m

$N = 3000$ lines per cm

$N = 300000$ lines per m

$\theta = 90^\circ$

$n = ?$

We know that

$$d \sin\theta = n\lambda$$

as $$d = \frac{1}{N}$$

$$\frac{1}{N}\sin\theta = n\lambda$$

or $$n = \frac{\sin\theta}{N\lambda}$$

By putting the value

$$n = \frac{\sin 90^\circ}{3 \times 589 \times 10^{-4}}$$

$$n = \frac{1}{0.1767}$$

$$\boxed{n = 5.66}$$

The highest order spectrum obtained with grating is 5^{th}

$$\boxed{n = 5th}$$